U.S. DEPARTMENT OF COMMERCE
National Telecommunications & Information Administration

Evaluation of the
Telecommunications and Information Infrastructure Assistance Program

Case Study Report

Quality Educational Scholastic Trust, Inc. (QUEST)
95018

Pittsfield, Massachusetts

Report Revised: August 27, 1999

Site Visitors: Paul Tuss and Nancy Speicher

Dates of Visit: February 25-26, 1998

PREFACE

On behalf of the National Telecommunications and Information (NTIA), I am pleased to share the following report that is one of a series of case studies conducted on grants awarded by the Telecommunications and Information Infrastructure Assistance Program (TIIAP) in 1994 and 1995. The case studies are part of the program's evaluation effort designed to gain knowledge about the effects and lessons of TIIAP-funded projects. NTIA contracted Westat, a research and consulting firm, to perform an independent evaluation of the program's first two years of grants. The evaluation consisted of a mail survey of 206 grant recipient organizations and in-depth case studies of selected projects. In February, 1999, the Commerce Department released Westat's evaluation report.

The projects selected for the case studies cover a broad range of program types and sizes, planning grants as well as demonstration grants, and they show varying degrees of implementation, sustainability, and replication. Westat selected the projects to represent a cross-section of all projects funded in the program's first two years. Specific selection criteria included geographic region, target population, project application area, project category, and size of award. To conduct each case study, Westat reviewed all project files, including progress reports and the final report, and conducted site visits. The site visits consisted of project demonstrations and interviews with project staff, representatives of partner organizations, and project end users.

NTIA thanks the case study participants for their time and their willingness to share not only their successes but their difficulties, too. Most of all, we applaud their pioneering efforts to bring the benefits of advanced telecommunications and information technologies to communities in need. We are excited about the case studies and lessons they contain. It is through the dissemination of these lessons that we extend the benefits of TIIAP-funded projects nationwide.

We hope you find this case study report valuable and encourage you to read other TIIAP case studies. You may obtain additional case studies and other TIIAP publications, including the final Westat evaluation report, through the NTIA web site (www.ntia.doc.gov) or by calling the TIIAP office at (202) 482-2048. We also are interested in your feedback. If you have comments on this case study or suggestions on how TIIAP can better provide information on the results and lessons of its grants, please contact Francine E. Jefferson, Ph.D. at (202) 482-2048 or by email at fjefferson@ntia.doc.gov.

Larry Irving
Assistant Secretary for Communications and Information

TIIAP CASE STUDY

Quality Educational Scholastic Trust, Inc. (QUEST)

EXECUTIVE SUMMARY

In response to the great disparity that existed between education services in Berkshire County and in the rest of Massachusetts, which tends to be wealthier and more populous, the TIIAP project's primary goal was to address the technology needs of the county's education system by establishing a wide area network (WAN) to bring Internet and other technology services to school and college sites. This WAN would provide faculty and students county-wide with the ability to communicate with each other, thus optimizing the teaching/learning experience for all.

The grant recipient was Quality Educational Scholastic Trust (QUEST), a non-profit corporation whose purpose is to provide access to state-of-the-art technology to all schools within Berkshire County and to provide students and teachers with training and assistance to take full advantage of those technologies. As a business partner to QUEST, the Lockheed Martin Corporation facility in Pittsfield agreed to assume a major role in design and technical activities. Lockheed Martin technical staff oversaw and maintained the technical data needs of the infrastructure, such as subnet addresses, domain name server addresses, IP addresses, and authorized user IDs for all sites. Lockheed Martin's technical service contributions included quarterly seminars for faculty throughout the county and onsite visits to individual schools as needed. Each of the 15 school districts in Berkshire County committed to finance and build computer networks within the schools. The districts paid for the network's frame-relay cloud and connection costs.

According to the project's final report, 39 public schools and two parochial schools serving over 15,000 students and educators in Berkshire County received Internet connectivity. All public secondary and middle schools have connectivity, as do 12 of the 32 elementary schools. In addition, the network server is being used by segments of the community other than the public schools that it was originally intended to serve. The county library system has put its entire library catalogue on the server. And the Internet infrastructure has been extended to include private schools, parochial schools, and public school administration buildings within Berkshire County. Utilization of the Internet infrastructure was also expanded to the residents and businesses within community via dial-in or dedicated access.

The network facilitated the accessibility and exchange of academic information previously unavailable in rural and geographically isolated Berkshire County. It provided opportunities for the exchange of teaching expertise, for professional development, and for Internet use to a population largely denied access because of fiscal and technical support barriers. These innovations helped make county students better prepared for college and the job market. They have also created an almost universal recognition among school principals and superintendents that Internet access is almost mandatory to maintain competitiveness. School officials are also beginning to recognize that staff training on network technologies is critical to successful technology implementation, so they have been increasingly hiring technology coordinators to provide training on the use of computer and telecommunication technologies. The use of Internet technology has also initiated an increase in the purchase and installation of hardware and software within the schools beyond original project plans. Furthermore, the public image of the school systems has changed for the better as a result of providing schools with Internet access.

Efforts to sustain the county-wide education network have primarily involved shifting the project's management and strategic direction decisions away from QUEST and toward the schools.

OVERVIEW

Purpose and General Approach

As stated in the grant application,

> *The Berkshire County Educational Technology Network will connect 40 public schools and colleges and a major business partner, Lockheed Martin Corporation, to the Internet and to each other. The technical support for the network will be provided by the engineering expertise at Lockheed Martin Defense Systems (now General Dynamics), one of the largest employers in the county, thus making this venture cost effective and efficient. Most importantly, the Network will facilitate the exchange of academic information currently unavailable in rural and geographically isolated Berkshire County, Massachusetts. It will provide opportunities for the exchange of teaching expertise, for professional development, and for Internet use, to a population largely denied access because of fiscal and technical support barriers. The Network will place county students on an equal footing with those with whom they compete in college and in the marketplace*.

In response to the great disparity that existed between education services in Berkshire County and in the rest of Massachusetts, which tends to be wealthier and more populous, the TIIAP project's primary goal was to address the technology needs of the county's education system by establishing a wide area network (WAN) to bring Internet and other technology services to at least 40 public schools and college sites. This WAN would provide faculty and students county-wide with the ability to communicate with each other, thus optimizing the teaching/learning experience for all. The project was also designed to achieve the following objectives:

- Centralize network administration in order to minimize administrative responsibilities at individual schools;
- Secure the individual school networks from Internet attacks;
- Accommodate additional schools as the need arises;
- Provide professional development to support technology-based education at the network sites; and
- Provide technical guidance and support.

The intended end users of project equipment and resources were the approximately 20,000 Berkshire County public school students and the faculty who educate them. Many of these students were from low-income families, lived in rural areas, and attended regional schools. Their technology skills were minimal to nonexistent, and most had no awareness of the benefits to be gained through educational technology. The students employed network services for educational purposes specific to each discipline. The network was not intended to serve as an administrative tool.

The basic plan for connecting the county's public education sites was to first connect high schools, and finally middle schools, and finally elementary schools. The base architecture for the network, similar to what large corporations use, was a frame-relay "cloud" operating at 56 KB line speeds. The frame-relay cloud made the network more efficient by allowing users to bypass the server. The school sites were linked

to the network via high speed modems and digital based routers, which allowed modifications to the variety of PC-based LAN protocols in the county schools. Interface to the Internet for the network was through a central computer installed at the Lockheed Martin facility in Pittsfield.

The network design was flexible and open ended so that costs associated with adding additional capability would be add-on costs and not redesign costs. After the initial 40 school sites were brought on line, additional schools and other sites could be added with minimal configuration changes to the central computer server. And the capacity of the network could be upgraded as school site usage increased without rewiring the facilities. The design also supports the interconnection of other entities within the county such as colleges, libraries, and businesses, either by direct connection through a 56 KB line or via a less expensive dial-up telephone connection. In addition, the network lent itself to incorporation of such new technologies as ISDN and cable TV interfaces. The only area of high obsolescence is the central client computer, the routers, and the modems.

Training and development to help schools use and learn the technology was accomplished in a number of ways. The project director presented ½-day faculty training sessions at each site as they came on line. Schools and school districts assigned dedicated faculty to support the technology and work with other faculty members to educate and integrate the technology into the classroom. Lockheed Martin personnel conducted county-wide seminars on technology applications on a quarterly basis for all faculty at the sites involved in the project and provided technical support to individual schools on an as-needed basis. Technically literate parents also voluntarily provided technical support to the schools. In addition, the faculty involved with an earlier pilot demonstration project had developed technology-based instructional activities for their curriculum and strategies for sharing information via the network. These faculty members were given opportunities to share their expertise during the professional development phase of the project.

The grant period started in October 1995 and ended in March 1997. QUEST's long-range goal is to provide Internet connections to all schools in the county.

Description of Grant Recipient and Project Partners

Grant Recipient. The grant recipient for this TIIAP project was Quality Educational Scholastic Trust (QUEST), a non-profit corporation whose purpose is to provide access to state-of-the-art technology to all schools within Berkshire County and to provide students and teachers with the training and assistance that they need to take full advantage of those technologies. QUEST was founded in 1993 and incorporated in 1994 as an arm of the Central Berkshire Chamber of Commerce to raise money for schools. The QUEST board consists of 18 educators, administrators, business leaders, banking leaders, and technology experts. In addition to the funding received through grants and businesses, civic, and school partnerships, QUEST also receives all profits from the sale of commercial and residential accounts by the Chamber of Commerce. Contributions from the Chamber amounted to $10,840 and $11,220 for the years 1996 and 1997, respectively. These contributions to QUEST included the provision of bookkeeping services and office space.

Project Partners. As a business partner to QUEST, the Lockheed Martin Corporation facility in Pittsfield agreed to assume a major role in design and technical activities. Lockheed Martin technical staff oversaw and maintained the technical data needs of the infrastructure for all sites, such as subnet addresses, domain name server addresses, IP addresses, and authorized user IDs. Lockheed Martin's technical service contributions included quarterly seminars for faculty throughout the county and onsite visits to individual schools as needed.

Lockheed Martin contributed $56,400 of in-kind technical support for the Internet program to QUEST in 1996 and $12,000 in 1997. About 20-30 Lockheed Martin employees were active in providing over 4,000 volunteer hours of technical support during the grant period.

Each of the 15 school districts in Berkshire County committed to finance and build computer networks within the schools. The districts paid for the network's frame-relay cloud and connection costs. The total amount spent by the 15 school districts on local telephone service was over $500,000. The total amount spent for Internet service averaged out to over $20,000 per month.

Project Costs

NTIA funding totaled $225,000 to cover the following costs:

- $199,500 for equipment; and
- $25,000 in contractual costs.

The matching funds consisted of cash and in-kind contributions from several organizations. Cash contributions in the following amounts were received from local businesses:

- $10,000 from NYNEX Corporation
- $15,000 from Crane and Company, Dalton, MA
- $20,000 from the Berkshire Life Insurance Company, Pittsfield, MA

Cash contributions in the following amounts were received from the network sites:

- $148,000 for school-site wiring and equipment for LANs from the 39 school site locations; and
- $65,250 for school sites' monthly connection costs of site to node from the 39 school site locations.

Lockheed Martin provided support on a not-for-charge basis. Total in-kind contribution from Lockheed Martin for the six engineers was estimated to be $64,800.

Project expenses are detailed further in the tables below.

Project Budget

Categories	Federal	Non-Federal	Total
Personnel	27,500	40,000	67,500
Fringe Benefits		8,781	8,781
Equipment	137,000	240,000	377,000
Contractual	60,500		60,500
Other		65,250	65,250

Federal Expenditures

Category	Payee	Amount	Total
Personnel	Project Director	27,500	27,500
Equipment	Lockheed Martin	64,975	
	Racal Datacom	63,648	
	Pioneer Standard	7,196	135,819
Contractual	Lockheed Martin	13,498	
	Sprint	47,002	60,500

PROJECT CONTEXT

Community Description

Berkshire County, Massachusetts (population 139,352,[1] acreage 946 square miles) is a rural, isolated county with many small communities. The county extends from the Connecticut border to the Vermont border. It is bounded on the west by New York State, and its eastern and western terrain is mountainous, thus forming an effective barrier from the larger metropolitan areas in the northeast. The Berkshire Mountains make travel hazardous during the winter months and preclude network technologies relying upon the line of sight. Consequently, exposure to educational resources and technology advances is severely restricted for students and faculty in the county. Three regions of the county have maintained their distinct characteristics and identities. Pittsfield, the largest municipality, is a city of just under 50,000 residents located in the geographic center of the county. Most of the other communities are small towns ranging from several hundred to a few thousand persons. The median age in the county is 35.9 and the elderly represents the fastest growing sector in the Berkshire population. The student population in Berkshire County for the 1996-97 school year was 19,689. The faculty/staff population was 2,313. Berkshire County's 15 school districts have 32 elementary schools, 8 middle schools, and 12 high schools. Because some towns created regional school districts to share educational costs over a larger population, the school districts in the county are geographically large but small in student population.

Berkshire County is one of the poorer counties in Massachusetts. Using 1987 dollars, annual income for the average worker in Berkshire County has remained stuck at about $20,000 for the last 25 years as the industrial base of the county's economy has steadily eroded with many large employers, such as General Electric Transformers, Sprague Electric, and several large paper mills down-sizing or eliminating operations. The Massachusetts Department of Employment and Training unemployment rates for Berkshire County in February 1995 were 7.5 percent, compared to the statewide rate of 6.2 percent. Many families saw a significant decrease in income as manufacturing jobs were replaced by lower paying service sector employment. The resulting loss of wages has further isolated residents. The median per capita income in the County is $14,857 compared to a $17,224 median per capita income in the State (U.S. Bureau of the Census, 1991).

Status of Telecommunications/Information Infrastructure Environment Prior to the TIIAP Project

Prior to the TIIAP award, Berkshire County's technical infrastructure was rudimentary. The nearest Internet point of presence was Springfield, about 50 miles east of Pittsfield. Furthermore, the passage of the Massachusetts tax measure, Proposition 2 ½ in 1981, resulted in a devastating impact on schools. A level services budget has prevented towns from allocating additional funds to school districts, as they struggle

[1] Source: U.S. Bureau of the Census 1990.

annually to keep pace with inflation. As approximately 85 percent of budgets are tied to salary costs, school boards were forced to slash all but critical needs, and technology was not deemed critical. Combining these problems with the rurality of the area, the geographic isolation, and the discouraging economic situation, communication among students in the county was difficult and their ability to access information resources such as the libraries of larger universities or cities was restricted.

PROJECT IMPLEMENTATION

Activities/Milestones that Occurred Prior to the TIIAP Grant Period

In an effort to cope with the inadequate telecommunications and information infrastructure in the county, local school systems met with area business leaders in 1994 to develop a plan to advance the employment skills of the county's students, particularly their computer literacy and technology skills. In the plan, each school was partnered with a local employer who would help improve student's employment skills by providing plant tours, monetary donations, and adjunct educational resources.

Although the school/business partnerships were considered by all to be successful, as school officials became more aware of the needs of the local workforce, they began to recognize a great need to develop students' Internet and technology skills. This growing awareness was heightened by a needs assessment conducted by the Chamber of Commerce revealing that faculty and parents of high school graduates were greatly concerned about students' lack of experience with the Internet and other applications, which effectively handicapped graduates in both their college and career pursuits. However, it was readily apparent that no single school district had the resources or the expertise to obtain service on its own. It appeared, though, that approaching Internet service from a regional perspective might be a viable option.

In early 1994, Lockheed Martin entered the picture with an offer to donate time and expertise to help advance the technology capabilities of schools throughout the county by selecting four schools to serve as pilot sites and connecting them via a WAN. A frame-relay network, the Berkshire County Wide Area Network was established with four high schools, with additional support from the NYNEX Corporation, Bay Networks, the Central Berkshire Chamber of Commerce, and schools across the county, one each from the north, east, south and west regions of the county, serving as pilot sites. Services utilized via the network included inter-site e-mail, Internet, and curriculum coordination.

Three vendors donated much of the needed computer and telecommunications equipment. Lockheed Martin provided the technical support and some equipment. NYNEX provided a frame relay for these schools to have access to the Internet and each other. North Adams State College, which later became the Massachusetts College of Liberal Arts, provided the link to the Internet. Eventually, the University of Massachusetts provided a non-private link. When the network was completed, Lockheed Martin and its partners had contributed $73,000 in cash, equipment, and technical expertise to the project.

When other schools started asking for Internet access, the Chamber of Commerce suggested that QUEST assume responsibility for collecting money from schools, a task that Lockheed Martin could not or not allowed to do. At the same time, Lockheed Martin and QUEST began researching grant opportunities to subsidize the line costs and machinery to help expand the network. Their initial effort focused on a proposal for the TIIAP grant that was awarded in October 1995.

Activities/Milestones that Occurred During the TIIAP Grant Period

The initial phase of the network was completed in December 1995. In this phase, the central computer, the Lockheed Martin site, and hub sites at seven schools were fully operational. Additional schools were

brought on line throughout 1996. By December of that year, QUEST had connected 35 schools to the Internet. Six additional schools (including two private schools) came on-line in 1997, bringing the total to 41 schools. QUEST managed the implementation process and provided each school in the network with a router. Schools paid only for their telecommunications costs for Internet connectivity and any costs incurred for internal infrastructure. The hub sites were established and fully maintained by Lockheed Martin staff throughout the grant period.

Mass NetDay, October 26, 1996, proved to be a great incentive for schools to install their connections. The Mass NetDay Committee included help from IBM, Apple, Sun, DEC, Wang, Bay Networks, the Massachusetts Technology Collaborative, the Berkshire County school systems, and several small consulting organizations. These businesses provided hardware free or at cost, donated money to purchase hardware, and donated their expertise to ensure successful implementation. Volunteers from businesses, PTOs, community organizations, and school faculty gave their time to wire connectors, pull wire, set up servers, and feed all the volunteers. A second, less prominent, Mass NetDay was held on April 5, 1997, with only two schools participating. One school used the day as its official inauguration for Internet connectivity.

Critical to the stability of the project was the extension of the project from March 31, 1997, to July 31, 1997. With the extension, the project could continue without substantial changes until the end of the school year.

Steps Taken to Sustain Project Activities Beyond the TIIAP Grant Period

Efforts to sustain the county-wide education network have primarily involved shifting the project's management and strategic direction decisions away from QUEST and toward the schools. The main goal has been to maximize the use of the infrastructure that has been implemented to date.

The financial situation at QUEST was growing tenuous as a consequence of declining levels of corporate gifts and donations. Furthermore, the organization found itself inadvertently falling into the role of Internet service provider (ISP). About 250 Lockheed Martin employees and 300 community members were paying a small fee to receive Internet service through the Berkshire County Educational Technology Network. QUEST also provided frame-relay support for a few local businesses. The money collected through these activities (as well as through fundraisers and donations) were used by QUEST to offset the cost of the Internet connections in the schools. Because this approach was not found to be economically viable, QUEST began looking into ways to turn the network's non-school accounts over to a commercial ISP.

During the project, schools had to pay only their telecommunications costs for Internet connectivity and any costs incurred for internal infrastructure. With the grant's conclusion, QUEST started billing schools to cover the difference between any operating revenue generated by fundraising activities and current operating expenses. The schools agreed to assume this portion of the service.

Also concurrent with the ending of the grant period, General Dynamics (formerly Lockheed Martin[2]) began looking into alternative arrangements for housing the server. Management at General Dynamics was not as willing to absorb the costs associated with housing the server and providing 32 phone lines as Lockheed Martin management had been prior to the buyout. Furthermore, because the General Dynamics facility is highly secure, it is difficult for employees to gain access to maintain the server. Any visitors into the

[2] On January 1, 1997, the Lockheed site in Pittsfield became General Dynamics. General Dynamics outsources functions not related to its core business. Lockheed Martin continued to provide information technology services to the General Dynamics Pittsfield site and QUEST. The Lockheed Martin technical staff and the General Dynamics subcontractors continued to maintain its commitment to the project. They continued to monitor system performance and make recommendations to maintain service levels.

building, which is owned by the U.S. Navy, must be escorted at all times. Computer Sciences Corporation, a subsidiary of General Dynamics, provides technical services for the server on a volunteer basis. The computers and the Internet connection are being maintained by individual volunteers. Nevertheless, the level of support and maintenance has been much lower since the General Dynamics buyout. The U.S. Navy, on the other hand, is very concerned that Internet service continue to be provided to the schools. Several options for locating the server are being explored by General Dynamics and QUEST, including Berkshire Community College, Kay Bee Toys, and Berkshire Life Insurance.

Steps Taken to Sustain Project Activities Following the TIIAP Grant Period

Quest received $5,000 from Bell Atlantic New England in January 1998 to help the organization provide low cost Internet and data communication to Berkshire schools.

Issues and Problems

Financial. Identification of non-Federal matching funds was a slow and difficult process due to a lack of coordination with and among many entities that needed to submit invoices.

As schools have come to realize that Internet connectivity is a sizable financial commitment, some have backed away from Internet connectivity. Two schools dropped out of the program—one that connected to QUEST using dial-up dropped the service to stop incurring toll charges for telephone service and another dropped out after its district found an alternative way to connect all its schools to another ISP at a lower total cost.

Internet connectivity poses an economic problem for small, rural schools. Due to their distance from Pittsfield, the telecommunications costs for them are too high for their budgets. Furthermore, their smaller residential populations and lack of commercial businesses provide a much smaller tax base over which to spread the network infrastructure's fixed costs and its ongoing maintenance. A telecommunications model where price is a function of distance puts rural schools at a cost disadvantage. It is anticipated that some of the cost barriers in the more rural areas will drop when the Federal Communications Commission's Universal Service Plan goes into effect. With discounts weighted to favor rural schools, this will close some of the urban/rural disparity. Relying upon the Universal Service Plan, however, will delay deployment another year. QUEST is therefore attempting to offer partial and temporary solutions to this problem. One important solution was to abandon the original concept for the network in which a frame-relay connection would be provided for each school upon discovering that dial-in capability was sufficient and more cost effective for small schools. For example, New Marlboro School connects to the Internet using an ISDN line from the school to Mr. Everett Regional High School, enabling the schools to share a single frame-relay circuit. But even after the Universal Service Plan goes into effect, schools will continue to bear the costs of ongoing maintenance and support.

Billing. NYNEX originally delivered a single telephone bill to QUEST, making it difficult to determine individual school charges. This problem was resolved during the second quarter of the project by having NYNEX direct bill each individual school for their frame-relay circuits.

In another billing problem, Sprint did not receive payment for the Internet connection for almost half a year due to an incorrect billing address. When this problem was resolved, an ancillary problem arose. Since the billing arrears went back several months, money was not encumbered to cover these expenses outside of their current fiscal year. Districts were still working out how to pay for these bills at the time of the site visit.

Internet Traffic. As networks in each school building in the county have grown and expanded, particularly at the secondary school level, many districts were forced to explore additional ways to optimize their connections to the Internet and to increase the speed and efficiency of their internal LANs. Using QUEST as an Internet provider worked in the beginning, but as network traffic has increased, high-peak usage times have emerged during the school day when LAN and WAN access time slows to the point of frustration for many users. Also, because the number of network accounts requiring network management has increased beyond what General Dynamics (formerly Lockheed Martin) can optimally provide, members of the district would like to be able to take on the management of district accounts. Several QUEST member schools, notably the larger districts, now want fast network lines and are exploring ways to make it happen. The Pittsfield school system, for example, is looking into ways to support its own independent telecommunications network as part of a city-wide program. Central Berkshire County would need a single Internet connection via a T1 or T3 line to make this idea work. (Cost-savings could occur if schools could connect to each other rather than connect independently to the Internet.) Whether the schools in Pittsfield would still participate in and support the continuation of QUEST under this scenario or whether the county-wide collaborative would break up is a volatile issue. Some of the smaller schools would not be able to maintain Internet access on their own. School superintendents in the county want a study of what would happen if the collaborative dissolves.

Sustaining Public Interest in the Project. With some schools having Internet access since September 1994 and many others a year later, Internet connectivity in Berkshire County schools is now a given. As a result, the public fails to see the disparity between Berkshire schools and most schools across the state. Many do not comprehend that the technology deployment in this county far exceeds most other schools in the state.

Media coverage, which has been used successfully in the past to generate community interest, has diminished. The Mass NetDay in October 1996 garnered several articles prior to the event, whereas the April 1997 NetDay got a single article on the day of the event. Furthermore, fewer companies and fewer individuals came forward to provide volunteer assistance. Many schools do not have sufficient technical expertise within their own staff and rely on volunteers to provide technical assistance. Although it is not difficult for schools to find volunteers in general, it has often proven difficult finding volunteers with either enough technical skills to be of use or enough long-term commitment to make it worthwhile to train them.

System Security. System security was minimal in order to give the users broad latitude and access to the system. Telnet and FTP were unrestricted. At one point, unscrupulous users through Telnet took control over some functions of the operating system and server operations and brought the service down. Due to the wide open nature of the server, users perpetrating these actions could not be identified as persons with registered accounts or persons from other Internet nodes. Other situations were noted in which users placed damaging programs called “eggdrop bots” in several directories on the server and compiled them, thereby slowing down the server and compromising the password files.

At one point, an ISP in Europe notified the systems administration in Pittsfield that a user of the Berkshire County network was attempting to gain illegal access to its system. Through a comparison of the logs and records of both services, the bot was identified on both servers, as well as the user name from the server in Pittsfield. The “attack” on the European server was a violation of federal and state statutes. General access to Telnet and FTP was immediately discontinued. Systems operation removed Eggdrop from several directories. The project director notified local and federal authorities, and both the project director and systems operators cooperated fully with them when needed. The project director also convened a general meeting of the schools to review the situation and the resulting actions. Telnet and FTP access have been granted on a case-by-case basis. Schools were also encouraged to create their own policies to address their individual requirements beyond those covered in QUEST’s general policy.

PROJECT ACCOMPLISHMENTS AND IMPACT

This project was clearly a success. The project has accomplished its goal to connect 40 public schools and colleges (and Lockheed Martin Corporation) to the Internet and to each other, thereby reducing the isolation that has traditionally hampered schools in the county and providing a wealth of educational resources and opportunities previously unavailable. Furthermore, anecdotal evidence from project staff, as well as administrators, teachers, and students in the county's schools, suggests that educational performance in the academic community has improved. The technology has motivated and empowered students, while positively influencing instructional practices. There is still progress to be made, however, with respect to training school faculty and staff so that technology literacy is consistently high throughout the county.

Technology-Related Accomplishments

As stated in the project's final report, 39 public schools and two parochial schools serving over 15,000 students and educators in Berkshire County received Internet connectivity through this project. All public secondary and middle schools have connectivity, and 12 of the 32 elementary schools are on line. Districts in which all its schools have current connectivity include Pittsfield Public Schools, Northern Berkshire Vocational School District, Adams-Cheshire Public Schools, Lee Public Schools, Lenox Public Schools, North Adams Public Schools, and Mt. Greylock Regional School District. Only one school system doesn't have Internet Service, but they plan to get it.

Ten school systems use leased lines, six use dialup, and one uses ISDN. Most connect at speeds less than 64 kbps. The status of the networks vary in the different schools throughout the county depending on several factors. Differences among schools in acceptance and support of technology can be attributed to the issue becoming a high priority of parent-teacher associations, teachers, and the students themselves. The availability of local expertise was another important factor. Schools with a full-time technical coordinator had a great advantage in keeping abreast of the technology curve. And schools that had developed a formalized technology plan were more likely to expand their capacity and demand more services

Six districts use more than one ISP. Eleven use Quest; other ISPs used are BCN, InterAccess, Bell, BerkshireNet, Javanet, Meol, Taconic Net, and Williams College. All but one school connect to the service through a frame-relay circuit or other type of dedicated line—the remaining school connects through modem dial-in.

All of the approximately 14,000 students in the schools connected to the network, have their own e-mail addresses. No usage statistics for the student accounts have been compiled. E-mail, however, usage is compromised by the way the system is set up, which makes it difficult for students to receive messages from the outside. Some students have gotten around this by setting up addresses they can access through the Internet.

Receiving free Internet service served as a catalyst for schools to acquire information technology. The schools participating in the project have demonstrated a wide deployment of computers across all grade levels as well as considerable classroom penetration. Five of the school districts have video-conferencing capabilities, although only two districts use it routinely.

The reliability of the central computer and the Berkshire County Wide Area Network were reported to be excellent with nearly 100 percent availability.

Impact of the Project on Direct End Users

Although the technical implementation of the Berkshire County Wide Area Education Network was an unqualified success, professional development activities to train teachers in the use of the network technology varied in content, quality, and frequency. Principals who are comfortable with technology, and who can see its benefits, are most likely to ensure that teachers receive the training they need to integrate technology into the school's curriculum. And teachers who were most aware of the value of new communications technologies were most adamant that their schools provide the requisite training. Younger teachers and science teachers were found to be most interested in obtaining classroom Internet access and training.

Schools obtained their professional development through a variety of options. Many of the schools relied upon existing staff to conduct training. The QUEST project director also conducted some sessions on an as-requested basis. Some schools tapped into the expertise from other schools outside of the district. Staff development seemed to occur on in-service days or during after school sessions. Generally, schools did not make wholesale changes in their schedules nor were teachers relieved of their pedagogical responsibilities for extended periods to accommodate training.

Despite the inconsistent training provided throughout the county, the wide area network and the associated Internet access were found to enhance schools' capabilities and increases their resources to provide a broad array of learning opportunities for students. Schools were no longer isolated by mountains and distance because they could communicate with students and other people from all parts of the globe. Schools that were too small to afford a library had access via the Internet to previously unobtainable reference materials and information resources. Schools without enough students interested in a particular topic to hire a teacher for them pooled their resources and instructors and offered courses via distance learning channels. Internet connectivity has provided schools with the opportunity to expand their course offerings at minimal costs. This is particularly useful in areas such as Berkshire County where the student population at any single school does not generate the critical mass that would justify hiring a teacher for courses apart from the traditional offerings.

The technology associated with the project was reported to have become an academic motivator. Educators have observed improvements in student work since the network has been in operation. Students' presentation skills have become more polished. They have learned how to conduct research more efficiently. Students are learning to evaluate information found on the web. They have readily embraced the opportunity to pursue their own avenues of inquiry. And they are better prepared with the technical expertise required in college and industry.

Visits to four county schools tend to corroborate these accounts. As a result of this project, there is clearly a renewed excitement and interest in teaching avenues by the faculty and in learning by the students within the schools we visited. Students were producing written and visual presentations in all courses. In science, in particular, there were a lot of Internet resources like the National Library of Medicine website's Visible Man and Visible Woman, and software programs such as the digital cadaver being used in classes. In English, there was a lot of word processing that was felt to have dramatically improved students' writing skills. Involvement in Computer –Aided Design (CAD) and other technology-based vocational classes has grown in popularity. Even art and music courses are using educational software. In contrast, few supplementary software programs or Internet resources were reported to be used in mathematics courses due to an apparent (or perceived) lack of quality math-based educational resources.
Other uses we observed or heard about include:

- Many students, especially at the high school level, created their own web pages.

- Students developed and printed event tickets, brochures, and flyers for school activities in their graphic arts classes.

- A travel and tourism curriculum was developed that uses the Internet as its primary resource.

- A few classes have been involved in Internet discussions with students from other countries. For example, students in a German class have been communicating with former foreign exchange students in Germany.

- One school, Mt. Everett Regional High School, has been taking advantage of distance learning opportunities in such topics as avionics, Chinese culture, and medieval European history. These courses, among others, are offered through colleges and universities across the country. The school gives students credit towards graduation for these classes.

- Many school newspapers and yearbooks are produced entirely in house using desktop publishing technologies.

- A multimedia presentation on alcohol and cigarettes was done by high school students for 5th graders. All research was done on the Internet, and the presentation was prepared using PC technology.

- Second graders authored and produced their own book. All research was done on the Internet, and the book was created in their own words with the use of PC software.

- A high school enabled students to access the school library from home or from any classroom. Students can query the card catalog for available topics and authors, reserve a book; or obtain local library information.

- Student in an economic class used the Internet to study and track the stock market.

- One high school offers an entrepreneurial class called TEK2000 that is modeled on a computer consulting firm. Students in the course learn the technology and the theory in the classroom and then apply it. They support the computer hardware in the school. They build computers for a fraction of the retail price of a comparable machine and sell these machines within the community. They function as a computer repair service to the community. They also design local area networks and run wires for connectivity.

Impact of the Project on Other Beneficiaries and/or the Overall Community

One measure of the success of the project is that the schools involved have increased their demand for Internet services. There is now an almost universal recognition among school principals and superintendents that Internet access is almost mandatory to maintain competitiveness. No longer are they content to deliver web pages to the classroom or allow students and staff to use e-mail. Schools want to move beyond providing web access and Internet literacy. One school, Taconic High School, plans to use the technology to allow staff to work from anywhere on administrative tasks. Other schools wish to gain more control over their account administration. (The QUEST network architecture presently precludes individual school control and places the responsibility centrally on system administration.) In response, QUEST has started to explore the possibility of changing the wide area network architecture to give schools more Internet protocol (IP) services and the control they desire. Schools are also beginning to recognize that staff training on network technologies is critical to successful technology implementation, so

they have been increasingly hiring technology coordinators to provide training on the use of computer and telecommunication technologies. The use of Internet technology has also initiated an increase in the purchase and installation of hardware and software within the schools beyond original project plans.

The public image of the school systems has changed as a result of providing schools with Internet access. This is borne out in the assistance Berkshire County schools received for Mass NetDay. As the schools have improved their reputation, a strong support network of parents, local businesses, major corporations, and other community members has developed. School district officials asserted that galvanizing community support for information technology in education through activities such as Mass NetDay is critical for districts to make the most of the benefits that technology can offer.

Schools have embarked on different projects using information technology, many of which directly help the community. The following describes some of these projects.

- One school saved approximately $175K annually in the last 2 years by eliminating seven buses after using a computer-based transportation schedule.

- Several high schools have provided computer training workshops for local companies and local government employees.

- Berkshire Community College uses the computer facilities in one of the high schools as a satellite classroom. As payment, high school students can attend the classes for free.

- A computer applications course at Drury High School introduced students to a broad variety of computer applications including word processing, database construction, spreadsheet development, graphing, and CADD,. Course assignments include problem-solving activities that require students to figure out which computer application provides the most appropriate solution. In an effort to make the exercises more realistic and to get the students involved in community activities, the instructor challenges each student to identify a community need and develop a proposal to address the need. Then, using presentation applications, the students justify their proposed project to their classmates. The class brainstormed ideas including an ice cream truck, roller rink, drive-in theatre, theme park, and helping the elderly to use computers. After some additional research, student presentations, and a vote, the class decided to plan an awareness festival for the proposed Ashuwillticook River Trail. They invited the Ashuwillticook committee president to the class to explain the rail-to-trail conversion and what the committee wanted as an awareness event. The committee president left the students highly motivated and with grant funding applications, a trail map, and a copy of a feasibility study done for the trail. The instructor's role was to organize the activities and to also teach the computer applications needed to complete the task. To date students have used word-processing skills to write a grant application, cover letters, and other letters for permission to use property; used paint and desktop publishing programs to design a logo and letterhead for their organization, Outdoor Recreational Trail Team; and used a database program to record contacts for the event. Students also use the Internet as a major research tool and posted the event at appropriate sites. The event will be a walk-a-thon/bike-a-thon on part of the proposed trail that will include a celebration involving food, music, prizes, and vendors.

- Nassacus, a school in the Central Berkshire Regional School District, has been preparing web pages for each of the seven towns within the district. Students research their community, speaking with residents to learn of the community's history, and meet with town officials to understand town administration.

- In September 1996, Downtown Pittsfield, Inc., called St. Joseph High School to ask about help with a web page. They were referred to a computer science teacher who offered the services of his students. Members of two computer science classes took on the job. They were already experienced in HTML, having created the school's web page. Within 2 weeks, the initial page was up and running. Students worked after school and at home on the site. All uploading was done at the school under the teacher's supervision. The page has been expanded and revised several times, most recently in April 1997.

  The project has provided the impetus for students to establish their own home pages, and several are now doing web pages for their own communities or parishes. The students are purists when it comes to web publishing. They use a text editor and write the HTML code themselves, rather than rely on publishing software. They worked with graphics, sound, client-side web maps, Javascript, and even Java.

In addition, the network server is being used by segments of the community other than the public schools it was originally intended to serve. The county library system has put its entire library catalogue on the server. And the Internet infrastructure has been extended to include private schools, parochial schools, and public school administration buildings within Berkshire County. As of March 1996, one parochial school and one public school administration building had obtained dedicated access. A school from outside of Berkshire County also connected into the system.

Utilization of the Internet infrastructure was also expanded to the residents and businesses within the community via dial-in or dedicated access. The use of the Internet technology within the community was intended to strengthen and reinforce the student benefits within educational institutes. It also was intended to provide growth opportunities to businesses and residents within the rural community and enable students to carry forth the use of Internet outside of the classroom. The Central Berkshire Chamber of Commerce offered and managed this service, while donating all profits to QUEST in support of the Internet technology for education.

From a Chamber of Commerce point of view, the project has enhanced the quality of life throughout the county, which attracts businesses looking to relocate. Furthermore, technology in existing businesses requires technical expertise. The project is meeting this need by ensuring that the skills needed by employees are available in the local population.

The project's effect on the local economy, however, has been minimal, despite the increased school expenditures on technology. Although schools spent well over $1 million to get Internet access, much of it did not go to support the local economy. The increased spending by the school districts on technology did not have a significant impact on the local economy because many of the schools purchase products outside of Berkshire County. However, the few local computer consulting companies for network design and support service, however, have benefited from the increased spending. And, although the schools' infrastructure investments did not generate an immediate corresponding increase in the county's income, its contribution to the county's quality of life and quality of education is expected to positively improve the region's economy in the long term.

Impact of the Project on Grant Recipient and Project Partners

The relationship between the schools and QUEST has become more collaborative as the project has evolved. Communications between QUEST administration and the schools were reported to have been more

unilateral than bilateral in the beginning of the project. As the project evolved, the schools began to take an increased interest in the project's administration and accept more ownership of the network.

This project has also fostered a shift in the relationships between schools and businesses. The school-business partnerships have evolved to include a broader community base. They have also diminished the school's dependency upon the businesses, leading to a more equitable relationship. The companies that participated as partners were convinced that their company benefited from the project not only because the children of employees were receiving a better education, but also because the entire community had improved its quality of life. Specifically, the project has helped companies attract and retain employees because they had an established reputation as a technology leader. A manager at General Dynamics (formerly Lockheed Martin), the primary partner in the project stated, "It is clearly important to get schools up and on the net. We live here. It has helped our kids and it has helped our community. A lot of volunteers have gained skills that have helped the company. We're trying to attract and retain talented people and we need a good school system and a community with a high quality of life if we're gonna do."

Project Goals Not Met

All of the stated goals of the project were met; however, a few evaluation and dissemination activities that were included in the proposal were never completed due to time and staffing constraints. This will be discussed further in the Evaluation and Dissemination section.

Impact of TIIAP Support on the Initiative

Without the NTIA grant, the deployment and penetration into the Berkshire County schools would be nowhere near its current level. The project director guesses that in the absence of TIIAP, Berkshire County may have been able to connect only the more progressive larger high schools in the county, but the network would have been less sophisticated and taken a longer time to accomplish. This is because the economics of Internet access precludes delivery to a small population such as exists in Berkshire County. Network start-up and ongoing operations require a substantial investment of capital.

EVALUATION AND DISSEMINATION

Evaluation

For Goal 1, establishment of an educational technology network in Berkshire County, the following evaluation activities were conducted:

- A baseline data survey of the Berkshire county schools was used to assess site readiness to join the network in spring 1994.
- Interview team measurement sheets were used to select and hire a project director.
- A listing of "on-line schools" was maintained and updated on a regular basis over the course of the grant period to track school participation in the network.
- The project director kept monthly reports of network activity to demonstrate that Network activities were conducted according to the proposed timeline by those individuals proposed to carry them out.

- The chief support engineer of Lockheed Martin filed quarterly technical reports to demonstrate that the operation of the plan was completed without major technical problems and supported fully by the technical team from Lockheed Martin.

- The project director completed inventory sheets to demonstrate that the appropriate hardware and software to support the network existed at each school site.

For Goal 2, administration of the network, the following evaluation activities were conducted:

- The project manager evaluated the project director on a quarterly basis and at the end of the grant period to assess whether the project director worked in accordance with the proposed plan.

- The project director distributed comment and evaluation sheets on a quarterly basis to allow the site participants, faculty, and students to be involved in project evaluation, addressing strengths and weaknesses as the program progressed.

- The QUEST Board of Directors kept minutes of their quarterly meetings to demonstrate an active and ongoing connection with the network and interface with the project director.

- The project manager maintained a calendar of project activities to demonstrate close supervision of the network and the project director.

- A Summary Budget Report was prepared to demonstrate that the project budget accomplished the plan set forth in the project application.

- Pre- and Post-Evaluation Forms were completed by network member sites to assess satisfaction with the progress made in the 18 months of the grant period.

- A final budget summary for matching contributions to the network was prepared to demonstrate that the matching support from businesses and corporations met or exceeded expectations.

For Goal 3, professional development support to network sites, the following evaluation activities were conducted:

- A schedule of training events was maintained to demonstrate that at-site and hub-site training in the technical aspects of the network took place for faculty.

- Professional Development Faculty Evaluation Forms were completed by faculty to assess whether the training provided by the project director and the Lockheed Martin technical teams were considered of value.

- Training materials exist which demonstrate that training materials were developed for the network.

- Professional Development Faculty Evaluation Forms were completed by faculty to assess whether technical assistance, beyond the knowledge of site faculty or site technical support, were available in a timely fashion.

- Professional Development Faculty Evaluation Forms were completed by faculty to assess whether curriculum development activities related to the use of the network and the Internet

occur in a positive manner. Results were used to inform and improve subsequent professional development activities.

- The project's Final Report included a discussion of the instructional and curricular impacts of the project which gave several examples of how the curriculum in various subject areas were enhanced by student use of the Network.

For Goal 4, Internet access through central node site, the following evaluation activities were conducted:

- Technical Team Installation Reports were completed to demonstrate that the hub site at the Lockheed Martin facility in Pittsfield was established and maintained.

- Technical Team Installation and Capacity/Monitoring Reports were completed to demonstrate that the installation of the Internet computer and the vendor wiring implementation accomplished the results outlined in the grant application.

- The project director completed site reports to demonstrate that the site hardware and software performed at quality levels to support the networks.

- Site facilitators completed evaluation forms to identify the measurable outcomes of the Internet connection for specific sites and for the network as a whole. Results were used informally by project staff; no report was prepared.

- Students in Berkshire County completed evaluation forms to assess whether they benefited educationally from the network. Results were used informally by project staff; no report was prepared.

For the overall project, the following evaluation activity was conducted:

- Newspaper articles, special news reports, etc. were collected to document any unexpected or unanticipated results from the project.

The major evaluation criteria for each of the project's goals are presented along with the corresponding data collection tools in the table below:

Goal	Criteria	Tool
1. Establish an Educational Technology Network in Berkshire County	Sites operating on line without major technical or usage concerns	L/M technical assessment forms
2. Central administration of the network	User satisfaction with project	Network member Evaluation Form
3. Professional development support to network sites	Thoroughness of technical and curriculum use training	Professional Development Evaluation Form
4. Internet access through central node site	Ease of access to Internet, ability to use services	Student Evaluation Form

The technical components of the evaluation were modeled on the capacity/monitoring and effectiveness ratings used in Lockheed Martin's engineering evaluation efforts; the curriculum and professional development evaluation components were based on current educational evaluation models.

The baseline data for evaluative purposes was assembled by QUEST in the spring semester of 1994. A thorough survey of the 13 public school districts and the two colleges participating in the project was conducted. The instrument for the survey was developed by Lockheed Martin personnel and was distributed to the 70 site locations in the county. The return rate of the survey was 92 percent, and the data gathered clearly delineated the hardware, software, wiring, and network capabilities of the sites. These data constituted the baseline against which the technical effectiveness of the project could be measured. Curriculum technology applications and professional development baseline data were also provided by the school districts.

The baseline data were to be used as the point of comparison in the ongoing evaluation. The effectiveness of the technical and programmatic aspects were measured separately. A summative evaluation report, structured to provide a programmatic, fiscal, and technical blueprint to the project, of this project was to be written at the end of the 18-month grant period. The report was to be disseminated by QUEST through the National Chamber of Commerce to areas demographically similar to Berkshire County. Due to a lack of time, funding, and personnel, followup data were not collected and the report was not produced.

Dissemination

The local press has done a good job covering the successes of the project and spreading information about the network throughout the region.

Taconic High School holds an annual event called the QUEST Expo. In the Expo, parents of Taconic High School students learned first hand about the Internet and its benefits. The schedule of events included a presentation by the Taconic High School technical coordinator, a tour of the computer labs, and a hands-on Internet session.

Potential for the Project to Serve as a Model

Although, the lessons learned in Berkshire County have broad implications for other rural, dispersed regions of the county, there is limited indication that other school systems have availed themselves of the opportunity (probably because there has been very limited dissemination of project activities and outcomes). One school system in Pioneer Valley, Massachusetts, requested and received assistance from Berkshire County to help them set up a network in the district.

LESSONS LEARNED

Project staff caution that Internet connectivity is not successful in and by itself. Success should be measured in the way schools use the technology to enhance and further education in their curricula. Information sharing, particularly for new curriculum uses, is vital to this success. Furthermore, by improving education, community support will naturally follow.

The project provided additional lessons for similar initiatives in the future.

Tactical. Because the initial business plan and budget for the project did not foresee the change in costs as more schools joined the project, the technology did not permit system upgrades that would match the incremental increase in school participation. Increases in the frame-relay line from the cloud to the server and in the connection to the Internet backbone altered the cost structure without offsetting revenues, because the addition of one school joining the network could force a system upgrade to accommodate an additional 20 schools.

A related issue is that the network grew faster than anyone expected, causing the file server to quickly become overburdened. The project also had to upgrade the wiring three times in the past 3 years to accommodate the growth of the system. Project staff advise building the basic framework four times as big as you anticipate needing.

Organizational. School superintendents and business managers were not originally part of the project. Any consultation between project administration and the schools took place with the technology coordinators. Missing from this arrangement was the school management perspective. Meetings between the project director and school business managers began in January and escalated to the superintendents' level by March. The project director presented the superintendents with a project overview, encompassing the network architecture, fixed operating costs, and grant status. They are now fully apprised of the project and can participate in long-term decisions regarding the project's direction and assume their share of the project's costs.

Although some schools in the county have hired technology coordinators, these individuals typically carry the entire burden of computer and telecommunications support, having responsibility for local area network maintenance, computer hardware purchasing, software purchasing, system security and administration, computer training, and general support, such as "break-fix." These responsibilities are too disparate and overburden the individual. They do not allow the coordinator to function competently as a resource to implement technology in a cost-effective manner and provide advice on new directions and solutions.

This project found it vital to have a significant corporate sponsor. This project would not have succeeded without the technical expertise provided by Lockheed Martin. They had significant knowledge of how to put networks together and had the necessary vision.

Strategic. Providing Internet access requires a clear understanding of its administration and economics. Project staff advise communities to work with existing Internet service providers whenever practical and possible rather than becoming a provider on their own. They found that operating an Internet service is fraught with economic pitfalls and misperceptions. This project would have been better off concentrating its efforts on developing infrastructure in the various schools to allow them to choose any Internet solution that suits their unique situations. QUEST would have functioned better as a broker between a coalition of schools and an existing ISP to find the best service at the best price rather than as an ISP dependent on the technical support of Lockheed Martin, which ultimately discontinued providing support to the project at the level it had grown accustomed to, severely weakening the overall program.

Project staff agree that forming a collaborative of multiple school districts helped the project gain an economy of scale necessary for optimal use of resources. At the same time they feel strongly that the educational system should not be segregated from the rest of the community. A thriving educational network needs to be connected to the public libraries, to homes, and to businesses. As such, the municipality rather than a school, district, or educational collaborative should be the backbone of the network. Schools will always fall behind the technology curve because they don't have adequate funding levels to stay on top.

Economic. Project staff attempted to make schools realize that technology is an ongoing commitment that should be built into their budgets every year. Furthermore, deployment requires an approach mindful of budget implications and in accord with a thorough technology plan. Technology coordinators should be strongly encouraged to develop their plans along with district business managers.

Schools need to shift their view of information technology from an expense to an investment, otherwise the often considerable telecommunications costs can become a never-ending impediment to continued Internet access. Access fees are only a small fraction of the total costs because providing Internet access is only one piece of a complex arrangement between ISPs, hardware vendors, computer consultants, telecommunications companies, and other miscellaneous businesses. Schools need to be aware of the total cost so they can plan their strategies to keep control of their budget during the implementation and the subsequent operation of the network. Otherwise unplanned incremental cost increases can place schools in a predicament—continue bearing the costs or stop Internet access.

Aggregating small schools and districts into a single collaborative spreads the substantial fixed costs for Internet service across a large population to reduce costs. It also helps for schools to have in-house expertise to help them define the full costs of service so that planning can take place for a successful implementation. Technical experts can also help schools recognize the productivity improvements to be gained through the technology innovations, thereby making the considerable infrastructure costs appear more realistic and worthwhile from an investment standpoint. For example, Internet connectivity has provided schools with the opportunity to expand their course offerings at minimal costs. This is particularly useful in areas such as Berkshire County, where the student population at any single school does not generate the critical mass that would justify hiring a teacher for courses apart from the traditional offerings.

Technical. This project has demonstrated that connecting schools across a geographic area with the size and topography of Berkshire County is entirely feasible and not excessively difficult. Frame-relay technology lowered this project's technical hurdles considerably. This should not imply that frame relay is the only telecommunications solution for a wide area network of this size. Other options include ISDN or even wireless transmission. The critical component is a reliable telecommunication infrastructure that provides scores of users sufficient bandwidth to operate their applications simultaneously.

Schools need to have a local area network infrastructure that connects to the wide area network. This should be the first step in delivering Internet access to schools. A LAN will reduce the per-student Internet costs by extending its deployment to a large population. Dial-in access for most schools is not an option because it limits the number of students who can use the system at any one time. A LAN provides a cost effective solution for campus-wide access as well as other computer services.

The network's utilization of a privatized frame relay network provided the security necessary to the schools, effectively blocking Internet attacks on the school servers at a cheaper cost than a fully functioning firewall. Having the privatized network does not permit as much flexibility and functionality or protection, but it is substantially cheaper and becomes an attractive option for a network operating with a very limited budget.

Societal. Community involvement and support are key components to connect a school to the Internet. Yet, they are only the beginning of a longer, more sustained effort to maintain and nurture the connection. Once a school has a connection, it begins down a path from which there is no return. It incurs costs for telecommunications circuits, hardware acquisition and upgrade, maintenance, and training. School administrators must find ways in their budgets to pay for this technology and still cover the other myriad demands to operate their schools.

Project staff found that treating all schools the same does not work. Although there are many common denominators, rigid formulas for implementation do not ensure success. Like the wide area network design, flexibility is a critical component in an implementation process or a network solution. Communication is also vital to a successful implementation. Internally, technical coordinators, teachers, and school management need to communicate regularly. Each of these representatives has a different stake in and

perspective on information technology. Reconciling these differences to forge a plan that garners consensus will increase the plan's acceptance and success.

Schools being separate entities have different needs. An Internet solution needs to provide flexibility and accommodate growth. Schools with different interests and needs will find a single solution restrictive and eventually may not find it suitable. This project created a single Internet solution for all schools, regardless of size. As schools became more familiar with the technology through experience and exposure, they increasingly sought to incorporate different applications into their educational and administrative environments. They pursued different technology paths, thus straining the capability of the original solution. Furthermore different economic burdens were borne by individual districts. Rural schools that were furthest from the frame-relay cloud had the highest costs and the smallest population base over which to spread the costs. Any solution must have the flexibility to change and evolve with the needs of its participants as well as the market's technology. It is imperative for potential participants to have a choice in their access strategies that balances costs with a school's capability to pay.

FUTURE PLANS

The grant's conclusion marks a transition in the QUEST program. As indicated previously (see Steps Taken to Sustain Project Activities), the project's strategic direction will shift to the schools. In order to inform this transition about what configurations each district wants and how to maintain an overseeing collaborative entity, an education survey is being planned.

In addition, technology has been advancing so quickly that project staff would like to reconfigure the system. They need a firewall. They want to be able to provide IP addressability, web posting, and domain name services. They want to expand to libraries in the county. Other county residents would like to be able to access the Internet from home. Seven of the county's 15 school districts are making plans to use video conferencing in the next 5 years. Municipalities could be supporting schools in this effort to help them keep up with technological advances. Schools are currently paying $40,000 for this system, which would cost $800,000 without the support that QUEST is providing currently. There are 550 users at $20 a month. These fees offset the school accounts. They would like to charge students and teachers $10 a month, which may enable the program to be self-sustaining.

The main problem is where to relocate the server so there is more and better access for the entire community. At the time of our site visit in February 1998, QUEST was preparing to transfer the provision of Internet service to commercial customers to an independent service provider. The transfer was set to take place on June 30, 1998. The Chamber of Commerce has solicited bids for an Internet service provider to replace QUEST in that role. At the time of the site visit there had been three commercial responses and two non-profit responses. There is also a possibility that Taconic High School could house the server for the central part of the county and the two non-profits could work with the north and south regions of the county. Whatever the solution, it is anticipated that the new ISP will be available at a comparable price while providing increased customer service and network reliability.

The network also wants to upgrade to a T1 line because the current connection to the Internet is too small for the volume of traffic in the county. Wireless receivers and frame technologies are two alternative connectivity approaches being considered.